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FIRST-YEAR PERFORMANCE OF DOUGLAS-FIR AND NOBLE FIR OUTPLANTED IN LARGE CONTAINERS

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by

PEYTON W. OWSTON, *Plant Physiologist*

and

WILLIAM I. STEIN, *Principal Plant Ecologist*

ABSTRACT

In early August, 1-1/2-year-old nursery-grown Douglas-fir and noble fir seedlings were potted into 10-inch-long cardboard and plastic mesh tubes, 7-inch-deep peat pots, and quart-size milk cartons. After growing several months outdoors, they were outplanted in fall or spring, along with bare-root 1-1's and 2-0's, on a site in the Oregon Cascades. First-year height growth of containerized trees averaged about 2-1/2 times greater than bare-root stock. Survival of all stock was relatively good but significantly higher for that in containers. Douglas-fir reacted differently than noble fir to transplanting while succulent and outplanting in fall or spring. Growth of all stock types will be measured for several years.

Keywords: Transplants, seedlings, container stock, seedling survival, seedling height growth, planting season, seedling succulence, transplant shock, Douglas-fir, *Pseudotsuga menziesii*, noble fir, *Abies procera*.

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INTRODUCTION

Several containerized regeneration systems have been developed in the last few years with heavy emphasis on mechanized production and planting.[1] But container planting must be proven biologically sound before it becomes a truly established reforestation technique. One test to determine its biological potential was begun in the Oregon Cascades in 1969. Survival and growth of 2-year-old Douglas-firs (*Pseudotsuga menziesii* (Mirb.) Franco) and noble firs (*Abies procera* Rehd.), outplanted in relatively large containers, were compared with results obtained by planting bare-root seedlings and transplants.

METHODS

In early August 1969, 1-1/2-year-old Douglas-fir and noble fir seedlings of appropriate seed sources were lifted from the U. S. Forest Service's Wind River Nursery near Carson, Wash. Most Douglas-firs were succulent and in a second flush of growth; the noble firs appeared less succulent, and many had set bud. Lifted seedlings were packed immediately in moist sphagnum moss, transported to Corvallis, Oreg., in portable coolers, and held in cool storage until potted by hand during the following week.

Following grading, 250 seedlings of each species were randomly allocated and potted individually into each of four types of containers (fig. 1):

1. Milk carton--polyethylene-covered cardboard, 1-quart size, 3 inches square and 9 inches deep, with drainage holes in bottom.

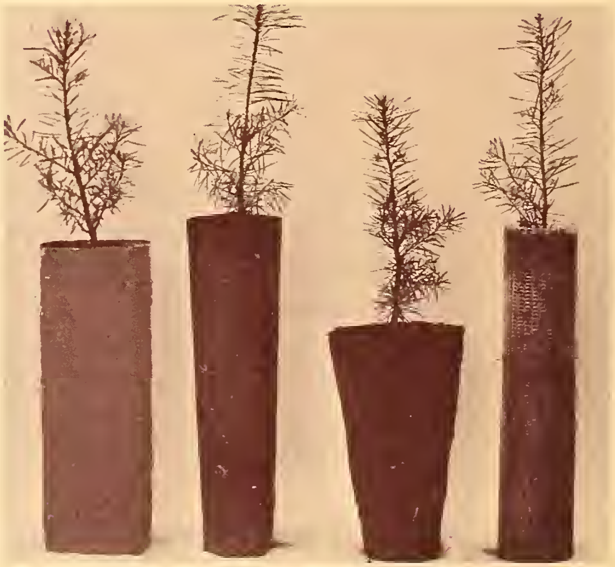

Figure 1.--Douglas-firs 2 months after potting in, left to right, milk carton, Weyerhaeuser tube, Fertil pot, and Conwed tube.

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[1] *Kinghorn, J. M. The status of container planting in western Canada. For. Chron. 46: 466-469. 1970.*

MacKinnon, George E. Container planting in Ontario. For. Chron. 46: 470-472, illus., 1970.

Western Reforestation Coordinating Committee. Containerized regeneration systems. In Western reforestation. West. For. & Conserv. Assoc. West. Reforest. Coordinating Comm. Proc. 1969: 28-49, 1969.

2. Weyerhaeuser tube[2]--resin-impregnated cardboard, 2-1/2 inches in diameter at the top and 10 inches deep, slightly tapered, with 1/8-inch holes in bottom and lower third of cylinder.

3. Fertil pot--pressed peat and paper fiber, 4 inches top diameter, 2 inches bottom diameter, and 7 inches deep.

4. Conwed tube--stiff plastic mesh, 2 inches in diameter and 10 inches deep, with cheesecloth covering the bottom opening.

Potting soil was a mixture of three parts sandy loam to one part peat moss, by volume.

Additional seedlings of each species were transplanted into 10-inch-deep flats filled with the same soil mixture; these transplants were prepared for use as nominal 1-1's. A second bare-root treatment consisted of seedlings left growing in the nursery until outplanted as 2-0's.

Both potted and transplanted seedlings were placed in coldframes at Corvallis and kept shaded and watered through the remainder of the 1969 growing season. They were sprinkled with Shive's nutrient solution during September. In late October, just before the first outplanting, ammonium sulfate fertilizer was lightly applied to seedlings in all pots and flats in an effort to correct slight foliage chlorosis. Meanwhile, seedlings left undisturbed at Wind River Nursery had been watered and fertilized routinely.

Potted and bare-root trees were outplanted on two clearcuts located within one-half mile of each other in the Whitewater Creek drainage, Willamette National Forest, near Detroit, Oreg. The study areas are on north-facing slopes on the west side of the Cascades; elevations range from 3,500 to 4,000 feet above sea level. Both areas were logged and broadcast burned in 1968. The sites are not considered severe.

Douglas-fir and noble fir were planted separately in four blocks each, two in each clearcut. Each block contained 12 rows, each row designated at random to be planted in the fall or spring with one of the six types of stock. Rows spaced 9 feet apart crossed the contours, and trees were planted 9 feet apart within each row. Planting of 25 trees per row was planned, but the actual number varied from nine to 25, depending upon the quantity of plantable trees available. Thus, total number of trees planted for different types of stock ranged from 163 to 200 for Douglas-fir and from 107 to 144 for noble fir.

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[2] *The identification and description of commercial products in this publication are solely for information purposes. Endorsement of any commercial product is not intended.*

Half of each type of stock was planted in late October 1969 by a Ranger District crew using long, narrow spades. Containers were inserted intact except that bottoms of milk cartons were removed to permit root emergence. Most cheesecloth bottoms on Conwed tubes had either fallen or rotted off, and cloth remaining was not considered a hindrance to root growth.

Remaining trees overwintered in coldframes at Corvallis and in seedbeds at Wind River Nursery. The trees at Corvallis were treated with 6-10-4 fertilizer in mid-March at a rate equivalent to 50 pounds nitrogen per acre. Almost all trees overwintering at Corvallis burst bud in early April and were in succulent condition when outplanted as soon as snow melted in late May 1970. Those from the nursery had tight buds; they had been lifted about 10 days before planting and placed in cold storage.

Survival counts and height growth measurements were made in late September 1970. Summarized data were analyzed for each species by analysis of variance methods appropriate for a randomized block design with treatments arranged in a 2 x 6 factorial. The container effects were isolated in a set of orthogonal contrasts. Standard statistical procedures were used to adjust for the unequal number of trees initially planted per treatment.

RESULTS

PERFORMANCE IN COLDFRAMES

Even though transplanted during the growing season, Douglas-fir recovered quickly and apparently suffered little damage. Most noble firs, on the other hand, began to lose needles the second and third weeks after potting. Some of these eventually died, but many burst bud in the spring and were outplanted.

Losses occurred in the coldframes during winter, causing a reduction of plantable Douglas-fir and a further reduction of plantable noble fir. They were lowest in flats and milk cartons and highest in Fertil pots--38-percent mortality of Douglas-firs and 50-percent of noble firs.

PERFORMANCE AFTER OUTPLANTING

First-season survival of containerized Douglas-fir averaged 95 percent compared with 83 percent for bare-root stock (table 1). Comparable averages for noble fir were 88 percent for containerized trees and 78 percent for bare-root stock (table 2). For each species, the difference in average survival was statistically significant.[3/]

Survival of Douglas-fir did not differ significantly among containers

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[3/] *Unless otherwise stated, statistical significance is at the 99-percent level of probability.*

Table 1.--*First-season survival of Douglas-fir*

Container or stock type	Average survival for each type of stock					
	Fall planting		Spring planting		Both plantings	
	Percent[1]					
Milk carton	87.5	(98)	97.0	(100)	92.2	(198)
Weyerhaeuser tube	97.8	(96)	98.8	(81)	98.3	(177)
Fertil pot	92.9	(100)	98.3	(63)	95.6	(163)
Conwed tube	89.8	(99)	96.2	(79)	93.0	(178)
Container average	92.0	(393)	97.6	(323)	94.8	(716)
1-1 transplant	82.8	(97)	85.2	(95)	84.0	(192)
2-0 seedling	78.5	(100)	87.0	(100)	82.8	(200)
Bare-root average	80.6	(197)	86.1	(195)	83.4	(392)
Average for all stock	88.2		93.8		91.0	

[1] Number of trees planted are listed in parentheses.

or between bare-root seedlings and transplants. Among containerized noble fir, survival differed significantly only for those outplanted in the fall in milk cartons, averaging 77 percent compared with 91 percent for those in other containers. Survival of noble fir transplants averaged 85 percent, significantly greater than the 70 percent for 2-0 seedlings. The difference was mostly due to very high survival of fall-planted transplants.

Survival of spring-planted Douglas-fir averaged 94 percent, significantly better than the 88-percent average for those planted in the fall. The difference in average survival between fall and spring plantings of noble fir was not significant.

Height growth of containerized Douglas-fir averaged 8.1 cm., significantly greater than the 2.8-cm. average for bare-root stock (table 3). Trees in the Conwed tubes grew fastest, followed by those in Fertil pots, Weyerhaeuser tubes, and milk cartons. Trees in the tubes and pots grew significantly taller than those in milk cartons. The difference in average

Table 2.--*First-season survival of noble fir*

Container or stock type	Average survival for each type of stock		
	Fall planting	Spring planting	Both plantings
	Percent[1]		
Milk carton	77.1 (72)	93.0 (72)	85.0 (144)
Weyerhaeuser tube	90.0 (71)	91.6 (72)	90.8 (143)
Fertil pot	95.5 (71)	86.1 (36)	90.8 (107)
Conwed tube	86.1 (72)	87.5 (72)	86.8 (144)
Container average	87.2 (286)	89.6 (252)	88.4 (538)
1-1 transplant	97.3 (73)	73.5 (71)	85.4 (144)
2-0 seedling	71.9 (71)	69.0 (71)	70.4 (142)
Bare-root average	84.6 (144)	71.2 (142)	77.9 (286)
Average for all stock	86.3	83.4	84.9

[1] Number of trees planted are listed in parentheses.

height growth between bare-root seedlings and transplants was not significant.

Height growth of containerized noble fir averaged 5.1 cm., significantly greater than the 2.1-cm. average for noble fir planted bare-root (table 3). This species grew fastest in Fertil pots, followed by Weyerhaeuser tubes, Conwed tubes, and milk cartons. Height growth differences between trees in the four types of containers were all significant. Height growth of bare-root transplants, 2.3 cm., averaged slightly but significantly better than the 1.8 cm. for bare-root seedlings (95-percent level of probability).

Height growth of spring-planted Douglas-fir, 7.1 cm., was significantly greater than the 5.6 cm. average for those planted in fall. There was only one exception to this general trend--in Fertil pots, fall-planted Douglas-firs grew more than those planted in the spring. In fact, they had the most growth of any fall-planted stock but averaged next to lowest among spring-planted, containerized Douglas-firs. Fall-planted noble fir

Table 3.--*First-season height growth of Douglas-fir and noble fir after outplanting in the fall or spring*

Container or stock type	Average height growth for each type of stock					
	Douglas-fir			Noble fir		
	Fall	Spring	Both seasons	Fall	Spring	Both seasons
	Centimeters					
Milk carton	6.0	6.8	6.4	5.0	3.5	4.2
Weyerhaeuser tube	6.5	10.3	8.4	6.2	4.6	5.4
Fertil pot	9.4	7.7	8.6	7.0	5.6	6.3
Conwed tube	7.1	11.1	9.1	5.4	3.7	4.6
Container average	7.2	9.0	8.1	5.9	4.4	5.1
1-1 transplant	2.2	3.3	2.8	2.5	2.1	2.3
2-0 seedling	2.6	3.2	2.9	1.9	1.8	1.8
Bare-root average	2.4	3.2	2.8	2.2	2.0	2.1
Average for all stock	5.6	7.1	6.4	4.7	3.6	4.1

averaged 4.7 cm. in height growth, significantly taller than the 3.6-cm. average for those planted in spring. Better growth of fall-planted noble fir was consistent throughout all container and bare-root stock types.

In addition to higher survival and faster growth, general appearance of containerized stock was superior to that of bare-root trees (fig. 2). Containerized trees of both species were stockier and branched more.

DISCUSSION

Two prime considerations influenced design of this study: (1) test the largest containers that might reasonably be used in western reforestation, and (2) determine biological potential of the containerized trees before becoming concerned with production mechanics. Increased survival and a two- to three-fold increase in first-season height growth on a favorable site clearly indicate that nursery

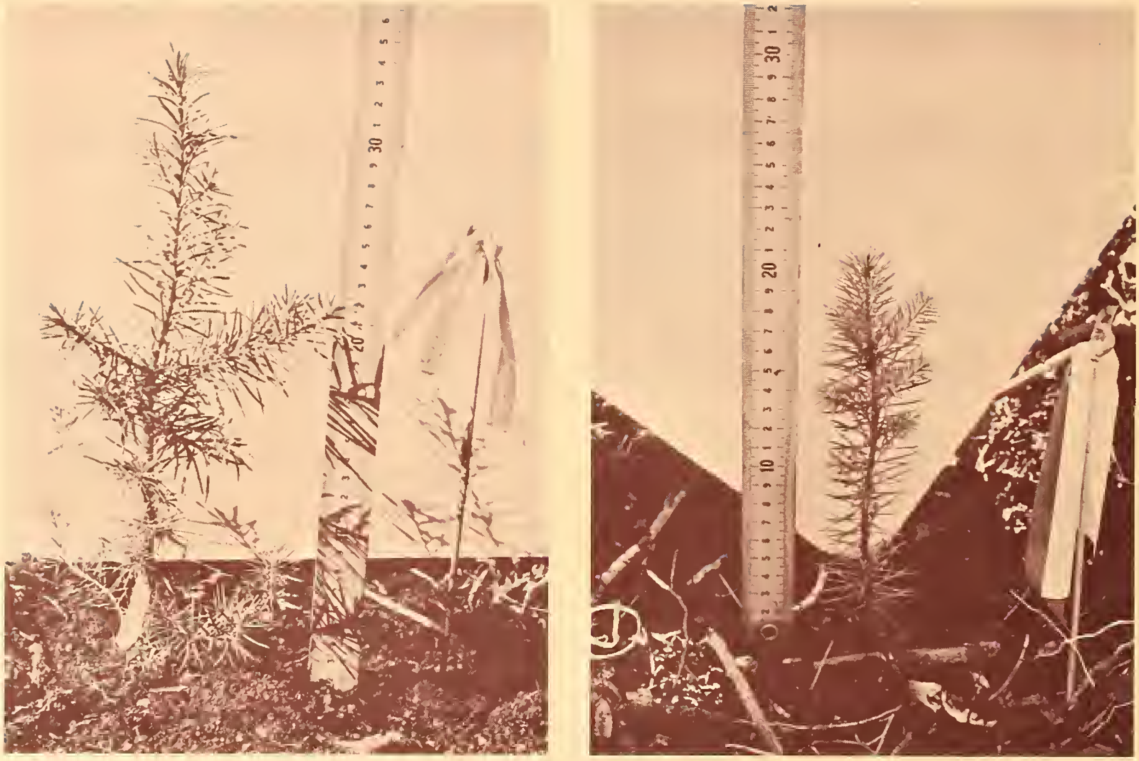

Figure 2.--Douglas-fir in Conwed tube (left) and bare-root (right) after the first growing season.

stock benefited from a conditioning period in containers. The biological effect might result from tree development during the conditioning period, from protection the container provides during transport and handling of the tree, from better soil moisture or nutrient conditions while roots become established, or from a combination of these factors. Differences in performance of bare-root and containerized trees might be accentuated even more on severe sites or in large-scale operations where bare-root stock does not receive the intensive care or careful planting it received in this study.

It could be argued that the improved performance of containerized stock is not due to the container and attendant intensive care but to the double culling such stock received. This possibility exists, but several pieces of evidence counter such interpretation: (1) all types of stock were culled to favor use of the sturdiest, healthiest trees available; (2) transplants received the same fertilization, watering, and double culling but did not match performance of containerized trees; and (3) in Fertil pots--the container with the highest wintertime tree losses--growth of spring-planted Douglas-firs was less than for those planted in the fall. Since the opposite was true for the five types of stock with less loss (culling), improved field performance can hardly be attributed to heavy culling.

During conditioning in the coldframes, trees were damaged by or died from two primary causes--transplant shock and late winter drought caused by insufficient watering during drying winds. Trees on exposed edges were damaged most. Field performance of containerized trees might have been even better if it had not been necessary to outplant many stressed and sparse-needled trees. With some change in future procedures, both causes of damage and mortality can readily be avoided.

Generally accepted planting instructions include the admonition that planting stock should be hardened off before lifting and outplanting. This precept was violated twice--first to launch the study in early August and, second, in delayed spring planting caused by lingering snow--with interesting consequences. Succulent Douglas-firs that were transplanted in early August and outplanted in late October survived and grew as well as 2-0 seedlings which hardened off at the nursery. Despite loss of needles, noble firs that were transplanted in August and outplanted in October survived and grew faster than the seedlings straight from the nursery. However, some noble fir transplants were culled prior to fall outplanting. Transplants of both species, outplanted after their buds burst in the spring, equaled or bettered survival and growth of 2-0 seedlings whose buds were still tight. These results indicate that greater flexibility in transplanting and outplanting than now practiced is feasible if the biological limitations of succulent seedlings are adequately determined.

Differences in survival and height growth arising from fall or spring planting of Douglas-fir and noble fir merit scrutiny. Survival and growth of spring-planted Douglas-fir averaged significantly better than for fall-planted Douglas-fir. Though sometimes minor, the planting season differences were consistent for seedlings, transplants, and containerized trees with one exception--in Fertil pots, fall-planted Douglas-firs grew more than those planted in the spring. This exception can probably be discounted because trees in Fertil pots dried out more over winter in the coldframes than any others. Thus, study results were consistent with the general operational experience that spring-planted Douglas-fir does best.

Unexpectedly, noble fir performance was substantially different. Height growth of fall-planted stock was significantly better and survival of fall- and spring-planted trees did not differ significantly. Two different explanations seem plausible: (1) perhaps this species cannot tolerate spring outplanting in a growing, succulent condition as well as Douglas-fir can, or (2) fall planting is intrinsically more favorable for noble fir. Future investigations to learn more about noble fir's nursery conditioning and its subsequent growth responses seem important.

Periodic remeasurement during the next few years should reveal how long these containerized trees sustain their initially faster height growth. Differences between containers may also become more pronounced, particularly if some containers impede root development. Milk cartons, the bulkiest and hence the most difficult containers to transport and plant, already appear less favorable for tree survival and growth than the other three types.

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